CLAIMS

1. A scanning electron microscope system including an electron energy analyzer, comprising:

a primary electron beam column for forming a primary electron beam and focusing it onto the specimen, the primary electron beam column including a high resolution objective lens that immerses the sample in a magnetic field; and

a secondary electron optical system for collecting secondary electrons through the high resolution objective lens, the secondary electron system including:

a lens creating an accelerating field for accelerating secondary electrons through the high resolution objective lens;

an electrostatic capacitor for deflecting the secondary electrons from the path of the primary beam;

a shield extending substantially through the electrostatic capacitor and shielding the primary beam from deflection and aberrations caused by the electrostatic capacitor , the shield being conductive on the inside to shield the primary beam and having on the outside a potential gradient to create an external electric field related to the electric field of the electrostatic capacitor, thereby reducing distortion of the field of the spherical capacitor caused by the shield; and

an electron energy analyzer for determining the energy of the secondary electrons.

2. The scanning electron microscope of claim 1 in which the electrostatic capacitor comprises a spherical capacitor.

3. The scanning electron microscope of claim 1 in which the shield comprises a tube or polygon.

4. The scanning electron microscope of claim 1 in which the shield comprises a pair of or multiple plates.

5. The scanning electron microscope of claim 1 in which the high resolution lens comprises a snorkel lens.

6. The scanning electron microscope of claim 1 in which the high resolution lens comprises a double pole magnetic lens.

7. The scanning electron microscope of claim 1 further comprising a transfer lens for adapting the output of the spherical capacitor to the input of the electron energy analyzer.

8. A scanning electron microscope system including an electron energy analyzer, comprising:

a primary electron beam column for forming a primary electron beam and scanning the beam across a specimen surface to cause the emission from the specimen of secondary electrons, the primary electron beam column including a high resolution objective lens; and

a secondary electron optical system for collecting the secondary electrons through the objective lens, the secondary electron system including a deflector for deflecting the secondary electrons from the path of the primary beam without significantly degrading the resolution of the primary beam.

9. The scanning electron microscope system of claim 8 in which the deflector produces a field for deflecting the secondary electrons and further comprising a shield that shields the primary beam from the field.

10. The scanning electron microscope system of claim 9 in which the shield is conductive on the inside and resistive on the outside to maintain a potential gradient on the outside corresponding to the field of the deflector.

11. The scanning electron microscope system of claim 8 in which the deflector is an electrostatic detector.

12. The scanning electron microscope system of claim 11 in which the deflector is a spherical capacitor.

13. The scanning electron microscope system of claim 9 in which the deflector is a spherical capacitor and in which the primary beam shield comprises a tube extending substantially through the spherical capacitor, the tube having a potential gradient on the outside corresponding to the field gradient in the spherical capacitor.

14. The scanning electron microscope system of claim 8 in which the high resolution lens includes a snorkel lens.

15. The scanning electron microscope system of claim 8 in which the high resolution lens includes a dual pole magnetic lens.

16. The scanning electron microscope system of claim 15 in which the dual pole magnetic lens comprises:

an upper magnetic pole piece having an aperture for passing the primary electron beam and the secondary electrons; and

a lower magnetic pole piece having a magnetic field generating coil, wherein the dual pole magnetic lens disposed in the first lens assembly focuses the primary electron beam and

focuses upward the secondary electrons including the substantial portion of the emitted Auger electrons from the specimen.

17. The scanning electron microscope system of claim 16 in which the upper magnetic pole piece includes a plurality of electrostatic deflection plates to selectively apply an electrostatic potential to substantially direct the Auger electrons towards the deflector as well as to scan the primary electron beam.

18. The scanning electron microscope system of claim 16 in which the lower magnetic pole piece is movably attached to mechanically move the lower magnetic pole piece upwards for relatively higher scanning electron microscope spatial resolution, higher Auger spatial resolution, and higher Auger electron transmission.

19. The scanning electron microscope system of claim 16 in which the sample can be raised or lowered for relatively higher scanning electron microscope spatial resolution, higher Auger spatial resolution, and higher Auger electron transmission.

20. The scanning electron microscope system of claim 8 in which the primary electron beam has a resolution finer than 5 nm.

21. The scanning electron microscope system of claim 8 in which the primary electron beam has a resolution finer than 2 nm.

22. The scanning electron microscope system of claim 8 in which the collection efficiency is greater than twenty percent for Auger electrons having an energy of 100 eV.

23. A method of determining the composition of a material on a specimen surface, the method comprising:

creating a beam of primary electrons;

directing the beam of primary electrons toward the specimen surface through at least a portion of an objective lens that immerses the specimen in a magnetic field;

directing through the objective lens secondary electrons emitted by Auger processes from atoms of the specimen;

deflecting the secondary electrons away from the path of the primary beam toward a secondary electron energy analyzer positioned off the path of the primary beam; and

analyzing the energy of the secondary electrons.

24. The method of claim 22 in which deflecting the secondary electrons includes adjusting an applied voltage to deflect secondary electrons having certain energies.

25. The method of claim 22 in which directing the beam of primary electrons toward the specimen surface includes passing the electron beam through a shield, the shield including an inner surface and an outer surface, the inner being conductive to shield the beam of primary electrons and the outer surface being resistive and charged to create an external electric field related to the electric field of the electrostatic deflector, thereby reducing distortion of the field of the deflector from the shielding tube.

26. A method of performing Auger electron spectroscopy using a high resolution scanning electron microscope, comprising:

directing a beam of primary electrons through an objective lens toward a specimen surface;

collecting Auger electrons through the objective lens, the Auger electrons forming a virtual Auger source at a disk of least confusion;

forming an image of the virtual Auger source off the path of the primary beam; and

analyzing the energy of the secondary electrons.

27. The method of claim 26 in which forming an image of the virtual Auger source includes using an electrostatic capacitor to form an image of the Auger source.

28. The method of claim 26 in which directing a beam of primary electrons through an objective lens toward a specimen surface includes directing the primary electrons through a shield to reduce aberration of the beam by fields used to form the image of the Auger electron source.